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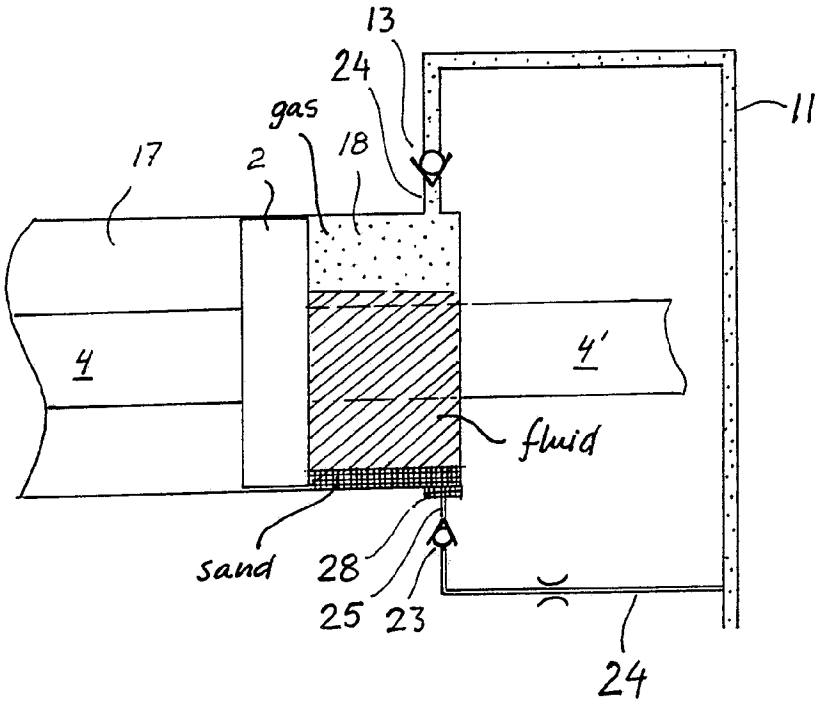
(54) Title: HYDRAULIC PISTON PUMP FOR THE COMPRESSION OF MULTIPHASE FLUID



(57) Abstract

The invention concerns a device for the compression of multiphase fluid, such as unprocessed petroleum well stream. The device is particularly suited for subsea installations. The principle mode of operation is a piston (12), which is powered by a high-pressure drive medium being directed by a control system, putting the multiphase media under pressure in a cylinder (1). The drive medium is reversed by the control system each time the piston reaches an end position.

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I:

Hydraulic piston pump for the compression of multiphase fluid.

The invention relates to a device as stated in the introduction to Claim 1 for the compression of multiphase fluid, e.g. unprocessed petroleum well stream.

In some industrial processes, such as petroleum production, chemical and petrochemical processes and hot water processes, a means is needed to pressurize complex fluids consisting of different gas_fluid mixtures and possibly solid particles. Conventional technology is based on a separation of the phases, before the gas and fluid phase can be pressurized in isolation.

Equipment is needed which can pressurize any multiphase fluid mixture with solid particles without any form of separation.

There is a great potential market for such equipment in petroleum production. Considerable financial benefits are envisaged both in the development and operation of marginal oil and gas fields if untreated well stream could be transported by pipeline directly to processing facilities onshore or on a central platform. If there is insufficient well pressure, or early production is decided upon, the well stream will require pressurization. Another advantage of compressing the well stream is to minimize the complexity of the flow conditions in the transport pipelines.

For most applications there are substantial advantages if the compression equipment is located on the seabed in conjunction with subsea wells. This places exacting demands on operational reliability and the resultant complexity of the equipment.

Numerous concepts are currently being developed to try to meet this functional requirement. A common feature of all these designs is that there is machinery with movable

mechanical equipment directly exposed to the well stream. This leads to the following drawbacks:

* There will be erosion damage if there are solid particles in the mixture.

* The machinery tolerates small variations in a mixture's gas/liquid ratio.

* The machinery generally operates with poor efficiency.

* The machinery is characterized by relative complexity.

Purpose of the invention:

The main purpose of the invention is to create a device that will increase the pressure in multiphase fluids, that can have greater effectiveness, operational reliability and more process parameter flexibility than known designs for similar purposes. The device is to be suited for subsea installation.

Principles of the invention:

The present invention comprises a device as indicated in the introduction to Claim 1, with the features presented in the characterizing part of Claim 1.

The present invention has the following advantages:

* The erosion damage caused by solids in the mixture will be considerably less than in known designs because all sealing surfaces are protected by a clean barrier fluid and there is low velocity between the moving mechanical components.

* The present design has no limitations concerning a mixture's gas/liquid ratio.

* The design will operate with high efficiency with all gas/liquid ratios.

* The components used in the system design are mainly based on known technology.

The invention will be described in more detail, with reference to the accompanying drawings, where

Figure 1 shows the principles of a device according to the invention in a diagrammatic drawing.
Figure 2 shows a detail of the design in Figure 1.

The system consists of a cylinder 1 which has a piston 2 inside. The piston 2 is forced forwards and backwards by a high-pressure drive medium being alternately supplied to two smaller diameter cylinders 3, which are located on each side of the main cylinder. Piston 2 has cylindrical end pieces, hereafter called the end pistons, 4 that act as pistons in the cylinders 3.

Seals 5 are located between the end pistons 4 and the drive cylinders 3.

The drive medium is supplied under high pressure through a pipe 8 to the compression system. A control system 6 with cartridge valves ensures that the high pressure drive medium is alternately supplied to one of the two drive cylinders 3. Each time the piston 2 reaches one of the end positions, the control system 6 makes a change over. Providing the drive medium is freshwater or seawater, the drive medium can be released to the surroundings through an outlet pipe 9. An alternative is to have the drive medium in a closed system. This means that the return pipe 9 must be connected to the pump unit 13 that pressurizes the drive medium. The pump unit 13 does not have to be in the immediate vicinity of the compressor system.

The multiphase fluid is fed into the compression system through a pipeline 10, and is led out by a transport pipe though pipeline 11. The respective pipelines are connected in series to end surface of the cylinder 1. Check valves 12, 13, 14, 15 are fitted to all pipe connections between pipelines 10, 11 and the cylinder 1.

The continuous operating of the device according to the invention can thus be described as identical sequences that follow each other in time, where a sequence starts from an end position. The cycle of a sequences on one side of the piston 2 is similar to the cycle on the other side of the

piston 2 except that the cycles on the two sides of the piston 2 are in opposite phases. The following description of a sequence is based on the situation shown in Figure 1, and the sequence is only described for one side of piston 2.

The sequence starts with a drive unit 21 driving a pump 16 that pumps high-pressure medium through pipe 8 to the change-over valve 6 that controls the drive medium to chamber 20 in cylinder 3, where the drive medium exerts a force on the end piston 4 in chamber 20. This force is further transferred to the piston 2 so that it is forced towards the left in Figure 1. When piston 2 moves to the left in Figure 1 this leads to an increase in pressure in chamber 17 in cylinder 1. When the pressure rise is sufficient, check valve 12 closes and check valve 14 opens, enabling the multiphase medium in chamber 17 to be pumped into pipeline 11 until chamber 17 is empty, and the piston 2 reaches its end position to the left in Figure 1. This causes the change-over valve 6 to reverse and control the drive medium into chamber 19 in cylinder 3 so that a force is exerted on the end piston 4 in chamber 19 which is again transferred to piston 2 forcing it to the right in Figure 1. This reduces the pressure in chamber 17 and when the pressure reduction is sufficient, check valve 14 closes and check valve 12 opens. This enables the multiphase medium to be pumped into chamber 17 from pipeline 10 until chamber 17 is full and the piston 2 is in the end position on the right in Figure 1. This causes the change-over valve 6 to reverse thus forcing the drive medium into chamber 20 in cylinder 3 so that the drive medium exerts a force on the end piston 4 in chamber 20 which is again transferred to the piston 2 forcing it to the left in Figure 1. This increases the pressure in chamber 17 in cylinder 1. When the pressure increase is sufficient, check valve 12 closes and check valve 14 opens enabling the multiphase medium in chamber 17 to be pumped into pipeline 11 until the piston 2 is back in the initial position shown in Figure 1, this sequence can then be repeated as long is required.

The inlet and the outlet for the product medium on the piston pump are shown in more detail in Figure 2. As it is symmetrical, only half is shown. The horizontal piston pump has a double outlet 24, 25 with two check valves fitted 13,23. The main outlet 24 is located at the highest point on the pump. In an expelling stroke the gas will be forced out first. The dead volume of the pump will be reduced so that it only contains a fluid phase, this will improve the volumetric efficiency of the pump. Sand which collects in the bottom of the cylinder is ejected during the pump stroke into a collection pocket at the lowest point 25 in the cylinder. This pocket is emptied after each piston stroke. A valve/fixed orifice throttle is fitted upstream of where pipeline 24 joins the high-pressure pipeline 11 to reduce the fluid flow through 25.

A control system 6 provides the correct sequence. The control system 6 comprises a number of cartridge valves. Cartridge valves are preferred to slide valves as the former have larger capacity and are more operationally reliable. Another matter is that slide valves require a lubricating hydraulic medium; whereas cartridge valves enable seawater to be used.

Claims:

1. A device for pressurizing a medium with one or more phases, consisting of a cylinder (1), which has a hydraulic double-acting piston (2) where the piston (2) together with the cylinder (1) surrounds two chambers (17,18), an inlet pipe (10) and an outlet pipe (11) for the medium, characterized by each end of the piston (2) having a protruding rod_shaped piston element that is connected to other cylinders (3,3') that surround chambers (19, 20) which are separate from chambers (17,18), and where pipelines are used for the supply, respectively removal, of hydraulic drive medium to the chambers (19,20) so as to drive the piston (2) alternately forwards and backwards in the chambers (17,18) while simultaneously sucking in the medium, respectively allowing the compressed medium to flow out through the valves (12,15; respectively 13,14).

2. A device as claimed in Claim 1, characterized by the piston (2) comprising a double-acting flushing system (26,27).

3. A device as claimed in Claims 1-2 for the pressurizing of a medium with at least two phases, characterized by chambers (17,18) being equipped with two outlet ports (24,25) with associated check valves (13,23) and where the outlets are located at the top, respectively the bottom, in chambers (17,18) so that each can remove what is mainly their own phase, first the gas phase in the upper outlet (24), then the fluid phase in the lower outlet (25).

4. A device as claimed in Claim 3, characterized by the removal of solids from chambers (17,18) in the lower outlet (25) by means of a pocket (28).

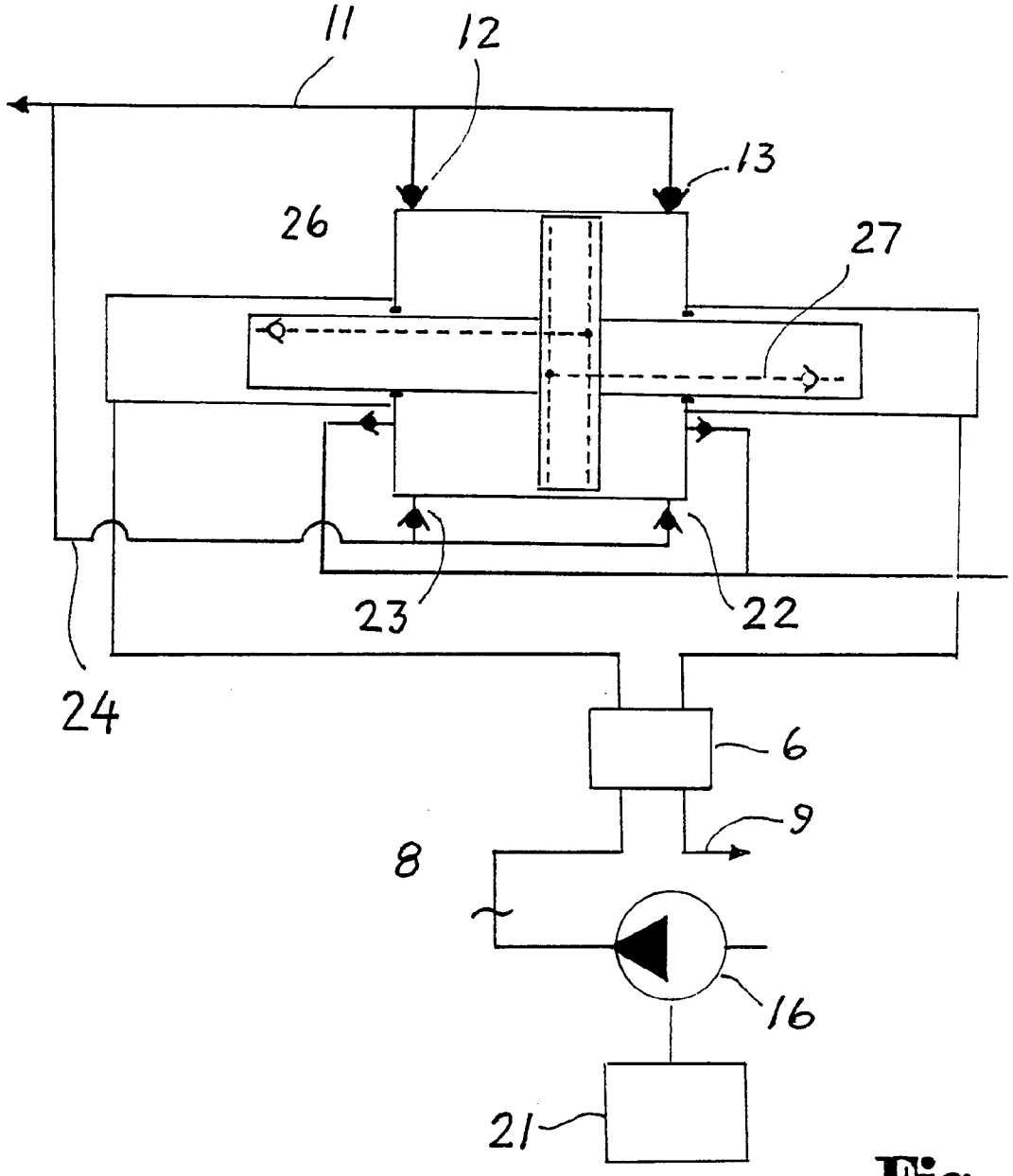

Fig. 1

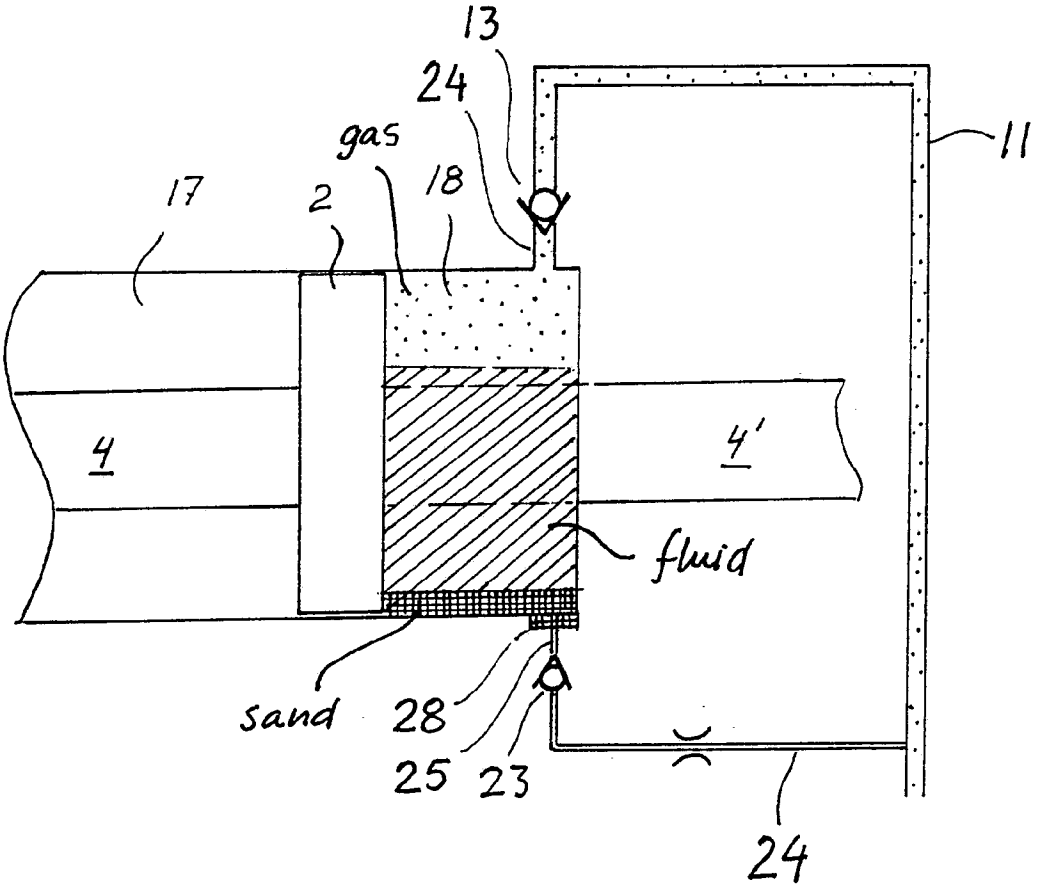

Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/NO 90/00030

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: F 04 B 9/10

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	F 04 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	SE, B, 326374 (N E NILSSON) 20 July 1970, see the whole document	1
Y	--	3
X	US, A, 4419055 (BURK) 6 December 1983, see the whole document	1
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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
7th May 1990	1990 -05- 15
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Sune Söderling

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/NO 90/00030

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 90-03-30
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
SE-B- 326374	70-07-20	NONE	
US-A- 4419055	83-12-06	NONE	
US-A- 1290803	19-01-07	NONE	